NIGERIAN AGRICULTURAL JOURNAL
ISSN: 0300-368X
Volume 50 Number 2, December 2019. Pp.193-197
Available online at: http://www.ajol.info/index.php/naj

PRE AND POST HARVEST STUDIES OF YAM DISEASES AND THEIR CONTROL MEASURE IN SOUTH EASTERN NIGERIA

[1]Akinbo, O.K. and [2]Opara, E.U.
[1]National Root Crop Research Institute, Umudike, Nigeria
[2]Department of Plant Health Management, Faculty of Agriculture, Michael Okpara University of Agriculture, Umudike, Nigeria
Corresponding Authors Email: oladunniakinbo@yahoo.com

ABSTRACT
Yam, (*Dioscorea* spp) is the most important food crop and source of income for millions of producers, processors and consumers in West Africa. In Nigeria, its production is constrained by many problems such as high cost of production, nematodes attack, vertebrate pests and pathogens singly or in combination. They are all responsible for field suppression and tuber quality deterioration in storage. Though yam tuber naturally has a periderm, microorganism that cannot get into, it is easily wounded by rodents, nematodes and man during field operation including weeding, harvesting and post-harvest handling. The wounds make room for the penetration and development of rot microorganism. The magnitude of these problems has made many to express fear that yam production in Nigeria may decline substantially in the near future. Due to all these problems of yam during pre and post-harvest, there should be a thorough control measure for both farmers and scientists to mitigate loss of yams both in the field and in the store (Barn). Some research has been conducted to test the potency of some plant extracts for the control of yam tuber rot caused by *Fusarium oxysporum, Aspergillus niger* and *Aspergillus flavus*. It was found that hot water extracts were obtained from leaf and seed of uda (*Xylopia aethiopica*) and Ginger (Zinigiber officinale), and were found during harvest, to be fungi-toxic against the fungi.

Keywords: Pre post-harvest, yam disease, control measures and South-East Nigeria

Introduction

Yam, (*Dioscorea* spp) is the most important food and income source for millions of producers, processors and consumers in West Africa. In 2012, world production of yam was estimated at 58.7 million tons with West Africa producing more than 92% (FAOSTAT, 2014). According to Akinbo *et al*., (2016), Yam (*Dioscorea spp*), a tuber crop that belongs to the family Dioscoreaceae of six different species that are edible which include: white yam (*Dioscorea rotundata),*water yam *(Dioscorea alata),* yellow yam (*Dioscorea cayenensis),* trifoliate yam (*Dioscorea dumetorum),* aerial yam *(Dioscorea bulbifera)* and (*Dioscorea esculentus).* In West Africa, *Dioscorea rotundata* is also referred to as white yam or white guinea yam which is widely cultivated. Statistics shows that Nigeria and Ghana together produced about 66% of the world's yam supply. About 48 million tons of the tubers are produced annually in this West Africa sub-region on 4 million hectares of land. Apart from Nigeria and Ghana, other yam producing countries are Benin, Cote d'lvoire and Togo and account for 93% of world production. Nigeria alone accounts for 68% of global production (36 million tons on 3 million hectares). Yam plays an important role by providing cash and dietary carbohydrate to millions of people and makes a substantial contribution to protein in the diet, ranking as the third most important source of supply of carbonhydrate. Nutritionally, yams are mainly carbohydrate food, but contain about 1-2% dietary protein, which is high compared with other tropical root crops. Yams are therefore, able to provide a good proportion of protein requirements of man when consumed in large quantities. In Nigeria, it is eaten as boiled, pottage, fried, roasted, pounded and as 'amala'(Yoruba). Yam is very important in Nigeria but its production is constrained by many problems such as high cost of production, attack by nematodes, vertebrate pests and pathogens singly or in combination. They are all responsible for field suppression and tuber quality deterioration in storage according (Onwueme, 1978). Though yam tuber naturally has periderm microorganisms that cannot permeate, it is easily wounded by rodents, nematodes and man during field operation including weeding, harvesting and post-harvest handling. The wounds make room for the penetration and development of rot microorganism (Noon, 1978). The magnitude of these problems has made many to express fears that yam

production in Nigeria may decline substantially in the near future (Orkwor *et al.,* 1998). This article therefore examines the problems associated with yam both before and after harvest and possible management measures.

Primary, Secondary and Derived Products

Yams are mainly grown for direct human consumption and are marketed as fresh produce in all the yam growing regions. Common methods of preparation include; boiling, baking or frying. Boiled and baked yam can be eaten with vegetable sauce or palm oil. Boiled yam can also be pounded or mashed in mortar and eaten as fufu or "utara". Commercially food automated processing equipment for boiling and mashing of yam into fufu are now available in the market. Yam cultivars, which contain toxic substances such as *dioscorene*, are first sliced and soaked in salt water for several hours before further processing for consumption.

For secondary and direct products, yam tubers are also processed into several food products such as the yam flour or 'amala', which are eaten in many parts of the tropics. Industrial processing and utilization of yam include: starch, poultry and livestock feeds, and production of yam flour. There are no specific standards for yam export, but intending exporters must seek information on the quality and phytosanitary regulations of the importing country as well as the product specifications required by the importers. As a guide, exporters should apply the general requirements for the International OECD Quality Standard which issues quality control such as minimum requirements, quality requirements, sizing, tolerance and packaging. These should be interpreted to assist in meeting the specifications agreed with the importers.

Consumer preferences

There are considerable consumer preferences for the different yam varieties among the growing regions. White-fleshed yams which have firm texture mainly *D. rotundata* are the most popular in West Africa, while in the South Pacific, *D. alata* cultivars (water yam, white purplish with loose watery texture) are most common. Consumer preferences might account for some of the predominance of certain cultivars in some regions, in addition to agro-climatological impacts on the growing attributes of the species. In some parts of West Africa, yams, which have loose texture, are often mixed with *gari* and pounded to prepare *fufu.* .

Diseases

The disease-causing agents reduce the quality and quantity of yam produced by making them unappealing to the consumers. Yam is prone to infection right from the seedling stage up to harvest and in storage. The diseases are classified into two: field and storage diseases.

Field Diseases

They are the diseases that cause economic damage to yam in the field from the seedling stage to the maturity stage.

1. Yam mosaic virus: It is caused by an aphid-transmitted poty-virus that infects several species of *Dioscorea*, particularly *D. alata*, *D. cayenensis*, *D. rotundata* and *D. trifida*. The symptoms observed in each host can be vein banding, curling, mottling, green-spotting, and flecking (Mantell, 1980; IITA, 1993). Yam mosaic virus (YMV) is considered to cause the most severe losses in yams and it is known as the most economically important virus disease of yam so far characterized and are caused by members of the poty-virus group.

2. Anthracnose: Anthracnose disease of yam has had a considerable impact on yam production world-wide (Nwakiti and Arene, 1978) which is caused by *Colletotrichum gloeosporioides* fungus (Nwakiti and Arene, 1978). *C. cingulata* is the perfect state of *C. gloeosporioides*, the form that is usually found causing field anthracnose disease. On susceptible yam cultivars, the symptoms appeared at first as small dark brown or black lesion on the leaves, petioles and stems. The lesion is often surrounded by a chlorotic halo, enlarges and coalesces which results in extensive necrosis of the leaves and die-back of the stem. The withered leaves and stem dieback gives the plant a scorched appearance, hence the name 'scorch' disease (IITA, 1993). Previous study (Amusa, 1997) indicated that yam anthracnose is a disease complex, which has however been associated with the activities of *Colletotrichum gloeosporioides*, *Curvularia pallescens*, *Curvularia eragrostides*, *Pestalotia species* and *Rhizoctonia solani.*

3.Water yam selective diseases: It is more commonly found on *D. alata*. Symptoms are: presence of chlorosis on the vein banding, flecking and leaf puckering. The organism has not been characterized (IITA, 1993).

4. Concentric leaf spot disease: Concentric leaf spot disease of yam has been reported to be the second commonly encountered fungal folial disease on yam. The causal agent is *Sclerotium rolfsii* according to Amusa (2000). Okpala and Eziakor (1989) first reported the wilting of yam vine caused by *S. rolfsii* in eastern Nigeria. The symptom of the disease is circular leaf spots of varying sizes that form concentric rings. At maturity, the center of the leaf spots contains sclerotia of the fungus. The lesion may merge together with the center eventually falling out due to necrosis. These circular leaf spots are observable both in the field and in the nursery causing not only spot but complete blight of sprouting yam.

Sclerotia are also produced at the base of the infected yam vine. Soil, plant debris and several weeds such *as Aclipha ciliata, Chromolaena odoranta, Euphobia heterophilla, Ipomea triloba, Commelina erecta* were found to harbour the pathogen (Amusa, 2000). The effect of this disease on yield has not been investigated, but has been observed that under severe attack, yield loss of more than 50% could be obtained.

5. Foliage fungi diseases: Other foliage diseases occasionally encountered on the yam field are zonate leaf spot induced by *Curvularia eragroistides,* and *Pestalotia macro-trichia (*Emua and Fajola, 1980; PANS, 1984; Amusa *et al*., 1996). Foliar symptoms of nematode infections on food yam tubers are occasionally observed. Early yellowing and leaf fall termination of vine growth have been seen on *D. rotundata* infected with *Micro. incognita,* but infections only rarely reduces tuber yield of yams (Adesiyan and Odihirin, 1978; Nwauzer and Fawole, 1981).

Storage Diseases

Yam tubers are harvested in Nigeria mostly between June and September and most of which are stored in different storage facilities depending on the cultural and traditional values as well as the technological advancement of the people of such area (Amusa, 2000) until consumption or replanting. During storage, the tubers are subject to losses of up to 50% of the fresh matter. Here, the losses due to microbial attack play a predominant role. The fungal pathogens penetrate through wounds in the tubers and infect the inner tissues. Such wounds are caused by insects and poor handling before, during and after harvest. Most of the yam rot induced by fungi in specialized barns near Idah, Kogi State, Nigeria were predisposed by insect attack by mainly storage beetles (*Coleoptera*), mealy bug (*Planococcus citri*) and scale insect (*Aspidiella hartii*) during storage. Treatments of the yam tubers with insecticide dust (Actellic 2% Dust; ai=pirimiphos methyl) significantly reduced fungal infections and also ameliorated physical damages acquired during harvest resulting in significant fewer fungal lesions. The storage diseases of yam can be categorized into 3 based on the symptoms and the causal agents (Amusa and Baiyewu, 1999)

1. Soft rot: The Infected tissues become soft ramified by the fungal mycelium. The causal fungi quickly ramified the tissue in which it turns brown and becomes soft and at times wet due to rapid collapse of the cell walls. Fungi associated with this type of rot are *Rhizopus* spp, *Mucor circinelloides, S. rolsii, Rhizoctonia solani* and *Armillariella mellea* (Ikotun, 1983, 1989; Green *et al.,* 1995; Amusa and Baiyewu, 1999).

2. Bacteria wet rot: Wet rot is characterized by the oozing of whitish fluid out of the tissue when pressed. This symptom is usually associated with a bacterium, *Erwinia carotovora pv carotovora* (IITA, 1993; Amusa and Baiyewu, 1999).

3. Dry rot: The symptoms though vary with varying coloration depending on the invading pathogen, the infected tissues become hard and dry. When tubers are infected with *Penicilium oxalicum* and *Panicilium. cyclopium*, the tubers turn brown, become hard and dry maintaining their integrity, except when the tissues are invaded by *Scherosiam. marcescens* (IITA, 1993). Such invaded tissues become covered with the greenish mycelia of the fungus. When tubers are infected with *Aspergilus niger* and *A. tamari*, such tissues subsequently turn brown with yellowish margin. *Rosellinia bunodes,* and *Botryodiplodia theobromae,* has been reported to cause dry black rot. The infected tubers first turned grey and then black, such tubers become pulverulent, breaking into small dry particles (IITA, 1993). Tubers infected by *Sphaerostilbe repens* had reddish mycelia on the rotted part. Infected tissues are discolored brown and smell fermented grains but maintained their integrity.

The yam nematode, *Scherosiam. bradys*, has also been found to the cause of decay of yam tubers known as " dry rot disease." This type of dry rot of yam occurs in the outer 1or 2 cm of tubers. The internal stage of the nematode dry rot consists of cream and light yellow lesions below the outer stem of the tuber. No external symptoms were found at the stage. As the disease progresses, it spreads into the tuber, normally to a maximum depth of 2 cm but sometimes deeper. In these later stages of dry rot, infected tissues first became light brown and then turned chatle brown to black. External cracks can appear in the skin of the tubers and parts can flake off exposing patches of dark brown, dry rot tissues. The most severe symptoms of dry rot are seen in mature tubers especially during storage where it is often associated with general decay of tubers. Water loss from tubers continued during storage and is significantly greater in tubers infected with *S. bradys*\ compared to healthy tubers.

Dry rot of yams alone caused a marked reduction in the quantity, marketable value and edible portions of tubers. Those reductions were more severe in stored yams. Adesiyan and Odihirin (1975) have reported that losses in a whole tuber can be as high as 80-100% in storage. The degree of pre-harvest damage to tubers by *S. bradys* varied from 0 to 40% in Nigeria (Wood *et al*., 1980). Knotting or galling and internal rotting of yam tuber has been found associated with *Meloidogyne spp*. In certain yam species, sprouting in galled tubers are often reduced or suppressed and root proliferation from galls on tubers can occur. Other diseases caused by *M. incognita* and *M. javanica* in stored tubers were reduction in the edible portion (more peel has to be removed), weight loss, and an

increase in the number of rotted tubers in both *D. alata* and *D. rotundata* (Nwauzer and Fawole, 1981).

Disease Management

The act of controlling yam diseases has been extensively studied which include:

1. The use of crop rotation, fallowing and planting of healthy materials and the destruction of infected crop cultivars (Nwakiti, 1982; Nwakiti and Arene, 1976; Ogundana. *et a*l, 1970).
2. For soil borne diseases like nematodes and sclerotium diseases, site on which yam plants were to be cultivated were often recommended for soil testing for the presence of the pathogen (Arene, 1987; Amusa, 2000).
3. Nematode disease can be controlled by the use of crop rotation and the use of nematicides such as carbofuran granular at planting.
4. Dipping of seed pieces in Nemacuron before planting also eliminates the inoculum of the pathogen from the planting material. Early plowing and thorough disking which exposes the sclerotia to early germination and exhaustion before planting have also been recommended.
5. Planting of yam setts with disease-free material were very effective in reducing nematode problems.
6. Yam setts are often treated with a suspension of *Fernasan D* or two handfuls of wood ash in 4 litres of water (Osai, 1993), after which the yam setts are spread under shade for the cut surface to dry before planting.
7. Use of virus-free planting materials and meristem culture has been recommended in the case of controlling viral diseases (Mantell, 1980).
8. Investigation has also carried out to test the potency of some plant extracts for the control of yam tuber rot caused by *Fusarium oxysporum*, *Aspergillus niger* and *Aspergillus flavus*. Hot water extracts were obtained from leaf and seed of uda (*Xylopia aethiopica*) and Ginger (*Zinigiber officinale*), and were found to be fungitoxic against the fungi. The extracts suppressed the growth of these fungi in culture and reduced rot development in yam tubers.

For post-harvest losses, minimizing physical damage of tubers during post-harvest operations has been recommended and is being practiced. Treatment of yam tubers with fungicides such as Benlate and Captan has been found to be effective in reducing fungal yam rot (Akinnusi *et al*., 1987; Ogali *et al*., 1991) or wood ash before storage (Osai, 1993) which are known to have little or no mammalian toxicity have also been recommended. Fungal infected yam tuber treated with Tecto at the concentration of between 0.6 and 1.0 kg /500 kg of yam tubers had significant reductions in weight loss compared with the control. Thiabendazole application has been reported to stimulate sprouting of yam minisetts. Yam like any other crop is often evaluated for disease incidence and severity in field and green house using artificial or natural inoculation of the pathogen. However, these screening procedures were very cumbersome and time consuming. Screening for resistance varieties with the use of toxic metabolite of *Colletotrichum* species has been found effective, reliable and comparable to the conventional screening methods (Amusa, 2000; Amusa *et al*., 1994). Due to all the above problems of yam during pre and post-harvest, there should be the application of a thorough control measure by both farmers and scientists to mitigate loss of yams both in the field and in the store (Barn).

References

Adesiyan, S.O. and Odihirin, R. A. (1975). Histopathology studies of the yam tuber (*Dioscorea rotundata* Roir) infected with *Scutellonena bradys* (Steiner& Hettew). International Bio-deterioration Bulletin 11:48-55.

Adesiyan, S. and Odihirin, R.A. (1978) Root-knot nematodes and pest of yams (*Dioscorea* spp.) in southern Nigeria. *Nematological*, 24:132-134.

Akinbo, O.K., Opara, E.U. and Ikoro, A.I. (2016). Isolation and Characterization of Soft Rot pathogen of Yam (*Dioscorea spp*) in Nigeria-A Review. 9(2): 198-209.

Akinnusi, O.A., Oyeniran, J. and Sowunmi, O. (1987). Effect of chemical treatment of yam stored in an improved yam barn. Report of the Nigerian Stored Product Research, Institute Technical Report, 17: 69-77.

Amusa, N.A., Ikotun, t. and Osikanlu, Y.O. K. (1994). Screening cowpea and soybean cultivars for resistance to Anthracnose and brown blotch disease using phytotoxic metabolites. *Afr. Crop Sci. J*. 2: 221-224.

Amusa, N.A., Ikotun, T. and Bankole, J.O (1996). Survey of leaf spot causing microorganisms on yams. *Afr. Crop Sci. J*., 4:111-113.

Amusa, N.A. (1997). Fungi associated with anthracnose symptoms of yam (*Dioscorea spp*.) in South-west Nigeria and their roles. *Crop Res*. 13:177-183.

Amusa, N. A. and Baiyewu, R. A. (1999). Storage and Market Disease of Yam Tubers in south western Nigeria. *Ogun Journal of Agriculture Research Nigeria*. 11: 211 – 225.

Amusa, N.A. (2000). Screening cassava and yam cultivars for resistance to anthracnose using toxic metabolite of *Colletotrichum* species. Mycopathologia 150: 137-142. Coursey, D. G. (1967). Yam storage I. A. review of storage practices and information on storage losers. *Journal of stored product Research*, 2: 227 – 244.

Arene, O.B. (1980). A disease of cocoyam in Nigeria caused by *Corticium rolfsii*. In: Tropical Root Crops. International Development Research Center: Canada, pp. 39-246.

Arene, O.B. (1987). Advances integrated control of economic diseases of cassava in Nigeria. In: Hahn Sk, Cavenes FE, (eds) Integrated Pest Management for Tropical Root and Tuber crops, pp. 167-175.

Emua, S.A. and Fajola, A.O. (1980) Leaf spot diseases of cultivated yam (*Dioscorea* sp) in south west Nigeria. *J. Root Crops*, 6:37-43.

FAOSTAT, (2014). Faostat.3.fao.ogr/faostat-gateway/go/to/download/Q/QC/E accessed on 01/08/2014.

Green, K. R., Sangoyomi, A. T and Amusa, N. A. (1995). The importance of *Rhizoctonia solani* as a pathogen of yam (*Dioscorea spp*) in Nigeria. In: Proceedings of the 6th symposium of the international Society for Root and Tuber Crops African Branch, Pp. 412-418.

IITA (1993). Crop Improvement Division/Tuber root Improvement Program Archival Reports (1989 - 1993). Part III yam,) *Dioscorea spp*. Ibadan, Nigeria, pp. 20-85

Ikotun, T. (1983). Post-harvest microbial rot of yam in Nigeria. *Fito Pathologia Bras*. 8: 1-7

Mantell, S.H. (1980) Apical meristem-tip culture for eradication of flexuous rod viruses in yam (*Dioscorea alata*). *Trop. Pest Management*, 26:170-179.

Noon, R.A. (1978). Storage and market disease of yam. *Trop Sci*. (20), 177-188.

Nwakiti, A.O. and Arene, O.B. (1978) Disease of yam in Nigeria. Pest Articles and News Summaries (PANS) 24: 468-496.

Nwakiti, O.A. (1982). Studies on the aetiology and control of anthracnose/brown blotch disease complex of *Dioscorea alata* in Nigeria. Ph.D Thesis, University of Nigeria, Nsukka.

Nwauzer, E.C. and Fawole, B. (1981). Root-Knot nematodes on Yams in eastern Nigeria Proceedings of the 3rd Research planning Conference on root-knot nematodes, Meloidyginy spp. Regine 1V and V. Ibadan Nigeria 16, pp. 1-167.

Ogali, E., Opadokun, J.S., and Okobi, A.O. (1991). Effect of lime and local gin on posr-harvest rot of yams. *Trop. Agric*., 31: 365-370.

Ogundana, S.K., Naqui, S.H. and Ekundayo, J.A. (1970) Fungi associated with soft rot of yam (*Dioscorea* spp) in Nigeria. *Trans. Br. Mycol. Soc.*, 54: 445-451.

Okigbo, R.N. and Nnaemeka, (2005). Control of yam tuber rot with leaf extracts of Xylopia aethiopica and *Zingiber officinale*. *African Journal of Biotechnology*, 4(8):804-807.

Okpala, E.U., and Eziakor, G.C.C. (1989). Sudden wilt of yam (*Dioscorea* spp) vines Ankponwu a new yam disease caused by *Sclerotium rolfsil* sacc. *Nig. J. Agric. Sci.*, 4: 67-70.

Onwueme, I. C. (1978). Tropical Tuber Crops: New York: John Willey and sons.

Orkwor, G. C., Asiedu, R. and Ekanayake, (1998). The importance of yams. In food yams. Advances in Research. I. J., (eds). IITA and NRCRI, Nigeria. pp: 249.

Osai, E.O. (1993). Microbial rot of yam (*Discorea* sp) minisetts and cassava (*Manihoti esculenta*) Ph.D. thesis University of Ibadan, Nigeria, 243 p. PANS (Pest Articles and News Summaries) (1984). Pest control in tropical Root Crops. Pp.147-162. In Centre for Overseas Pest Research, London, No.4.

PANS (1984). Pest control in tropical root crops: Pest articles and news summaries, Centre for Overseas Pest Research, London 4: 147-162.

Wood, T.G., Smith, R.W., Johnson, R.A., and Komolafe, P.O. (1980) Termites damage and crop loss studies in Nigeria- pre-harvest losses to yam due to termites and other soil pests. *Trop. Pest Management*, 26:355-370.